PROPOSAL FOR
SINGLE-TOWER CABLE-STAYED BRIDGE
EAST BAY REPLACEMENT

SUBMITTED TO

BAY BRIDGE DESIGN TASK FORCE

ENGINEERING & DESIGN ADVISARY PANEL

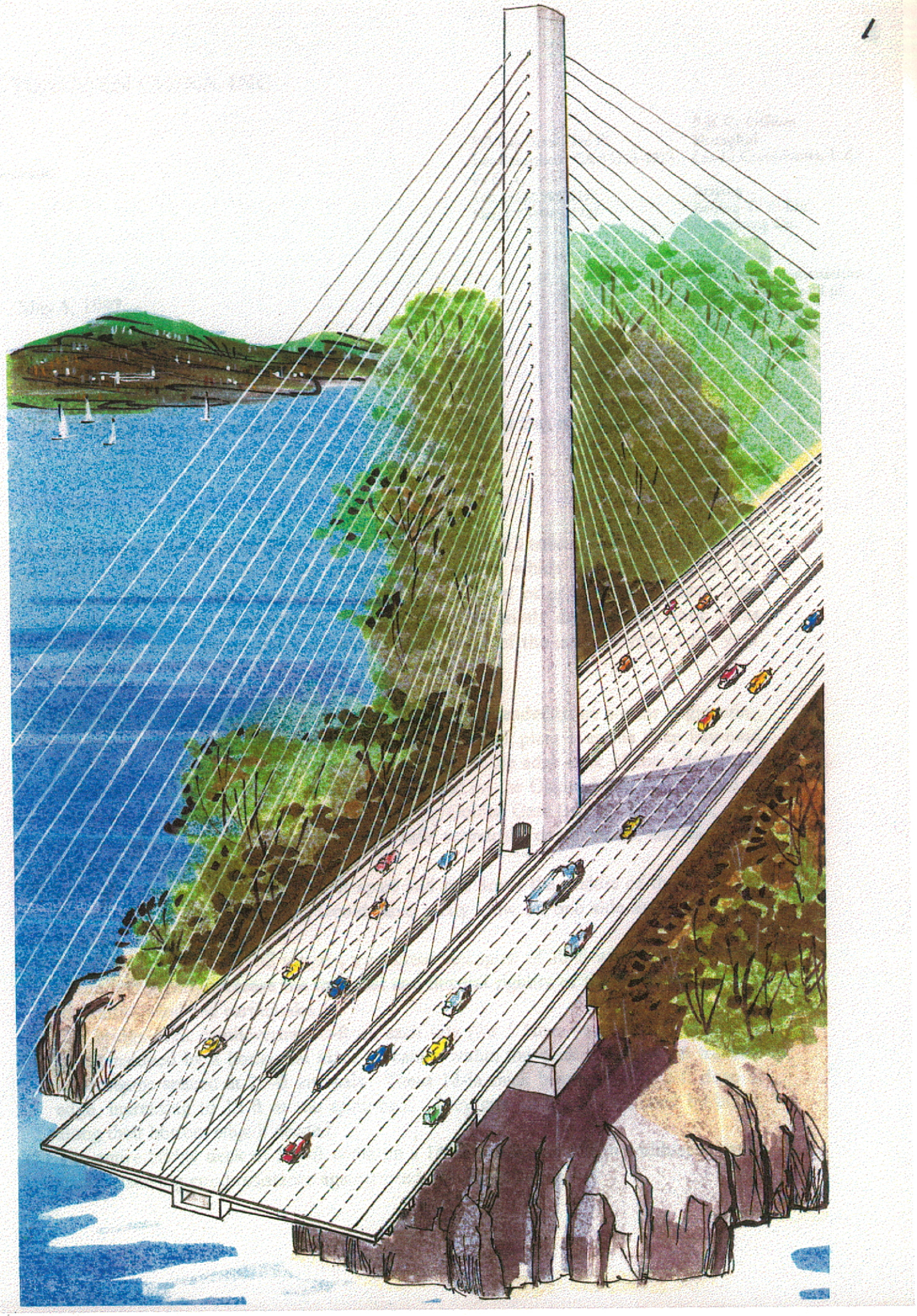
METROPOLITAN TRANSPORTATION COMMISSION

BY

T. Y. LIN,

BOARD CHAIRMAN, LTYC

MAY 5, 1997



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May 5, 1997

Engineering and Design Advisory Panel
Bay Bridge Design Task Force

RE: Single-Tower at Treasure Island for Main Span of East Bay Replacement Bridge

Dear Sirs:

As we all know, San Francisco Chronicle through Mr. Allan Temko asked me to create an alternative for the solution of the subject span layout, which was published in the Chronicle March 10, 1997 - attached. Since then, several other alternatives have been proposed and are being considered. This memo is to briefly describe the basic ideas underlying the single-tower proposal and to name some of the issues involved for your consideration.

(1) This single tower concept for cable-stayed layout is intended to be a clear engineering statement, emphasizing the desirability to do away with piers over the deep bay-mud near Treasure Island, and to place a single tower on the edge rock of that island. At the same time, this will create a monumental mast on the Oakland side comparable to the suspension towers of the West Bay and the Golden Gate Bridge. Of course, such a tower must be designed to be absolutely safe, seismically or otherwise, and this is not difficult to achieve.
(2) 2 parallel plans of stay-cables 25-ft apart will run down the middle of the bridge so that drivers in either direction would have a city view on one side and a towering structure on the other.
(3) The 2-planes of cables will support a concrete box spine of 30-ft wide and 12-ft deep which will greatly increase the torsional and flexural rigidity of the deck, stiffening it for traffic, wind and earthquake.
(4) The bridge-deck cantilevering 80-ft on each side (for 5 lanes plus shoulders) will be post-tensioned by a horizontal plane of cables within the deck and rests on traverse floor beams spaced at 25-ft internals. These 18-in thick beams will be 2-ft deep at edge, increasing to 12-ft at the spine box. They can be further stiffened by bulbs, along their bottom edge if needed.
(5) The entire bridge deck of 190-ft width on a 1400-ft span has a high width/span ratio, thus possessing good resistance against wind or seismic forces.

(6) This concept is believed to be an economical and esthetic solution befitting its environmental requirements. It is laid out to follow the single-deck approach spans presented in the Value Engineering Analysis performed by Ventry Engineers submitted to Caltrans, November, 1996. It will fit into other approach layout assuming a one-deck structure, but will not fit into a double-deck approach. Bikeway can be provided by leaving a small tunnel through the tower just above the deck.

(7) This proposal is intended for a prestressed concrete deck, although it can be modified into a composite deck if needed. The all-concrete approach is proposed for economy in construction and maintenance.

(8) Construction of the bridge will use the usual double-cantilever erection, with some modification for the unbalanced or asymmetric spans. Since the deck will have cantilever floor beams at intervals, the conventional horizontal slip-forming should be modified, perhaps by using jumping forms. One could slip-form the central box spine first. Then it will be followed by lowering the steel forms on each side of the spine to be jumped forward. Or, precast 80-ft T-stems can be lifted into position and deck slabs poured to connect them to the spine.

(9) Although the bridge is inherently safe, dynamic studies should be conducted to determine the responses of the structure to live load, wind, and earthquakes, to be sure of its safety under all conditions. Vibration under traffic will be minimum on account of the heavy size and weight of the bridge deck.

(10) The bridge alignment is only approximately indicated in the plan attached.

(11) Architectural features for the tower, pier, railings, etc. will be incorporated as needed in the future.

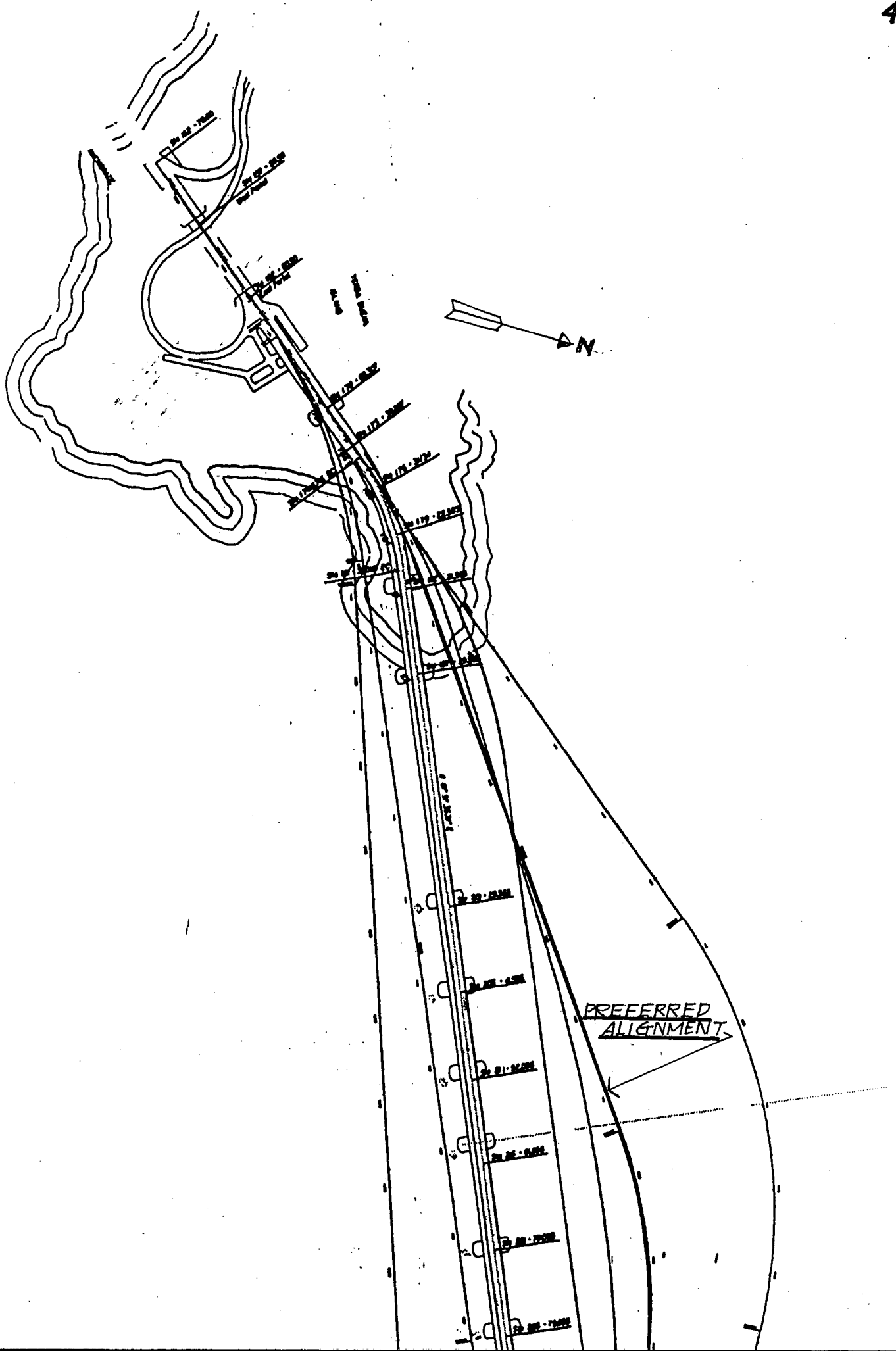
(12) The tower pier under the deck is about 160-ft high above water, 50-ft x 50-ft square, having 5-ft reinforced walls designed to resist heavy earthquakes. The foundation shall be a spread footing on rock without piles.

It is suggested that the Panel consider the incorporation of this concept, in part or in whole, together with whatever layout adopted for this bridge.

Sincerely,

T. Y. Lin

T.Y. Lin, Bd Chrmn, LTYC,
also Member of Task Force and CAPCD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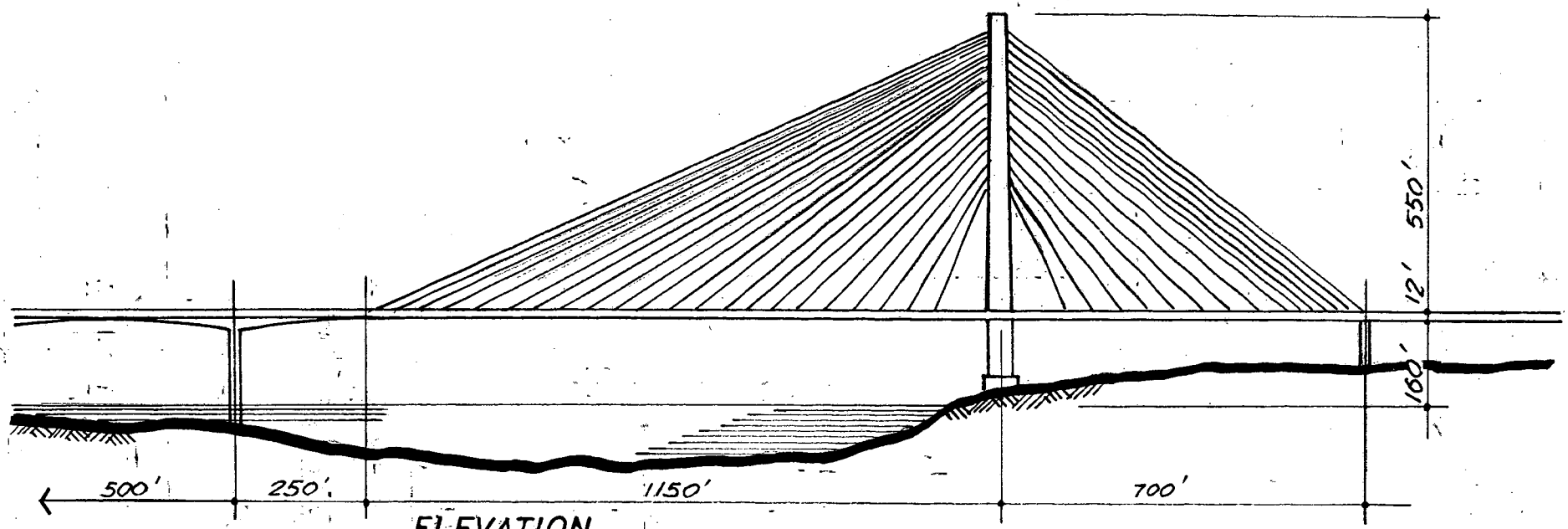
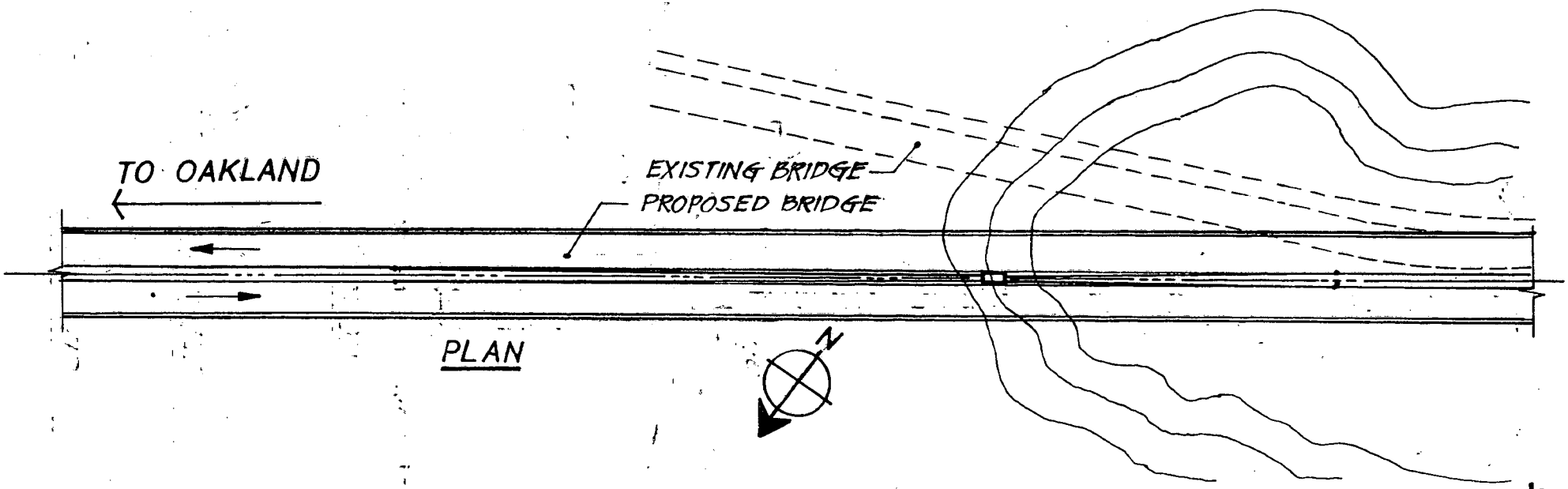
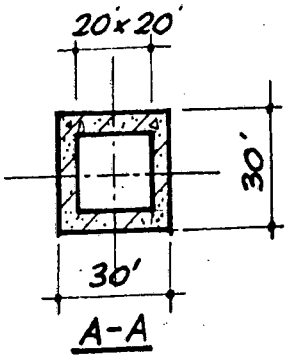


ELEVATION



PLAN



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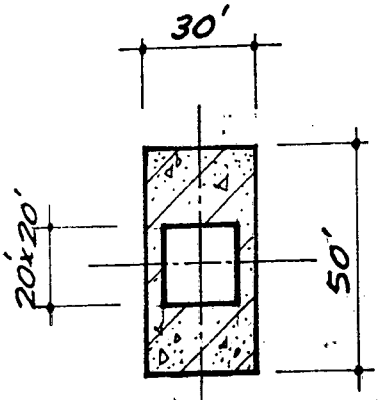

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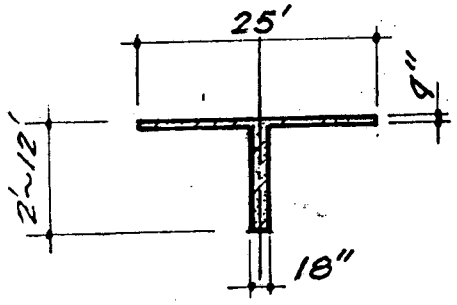

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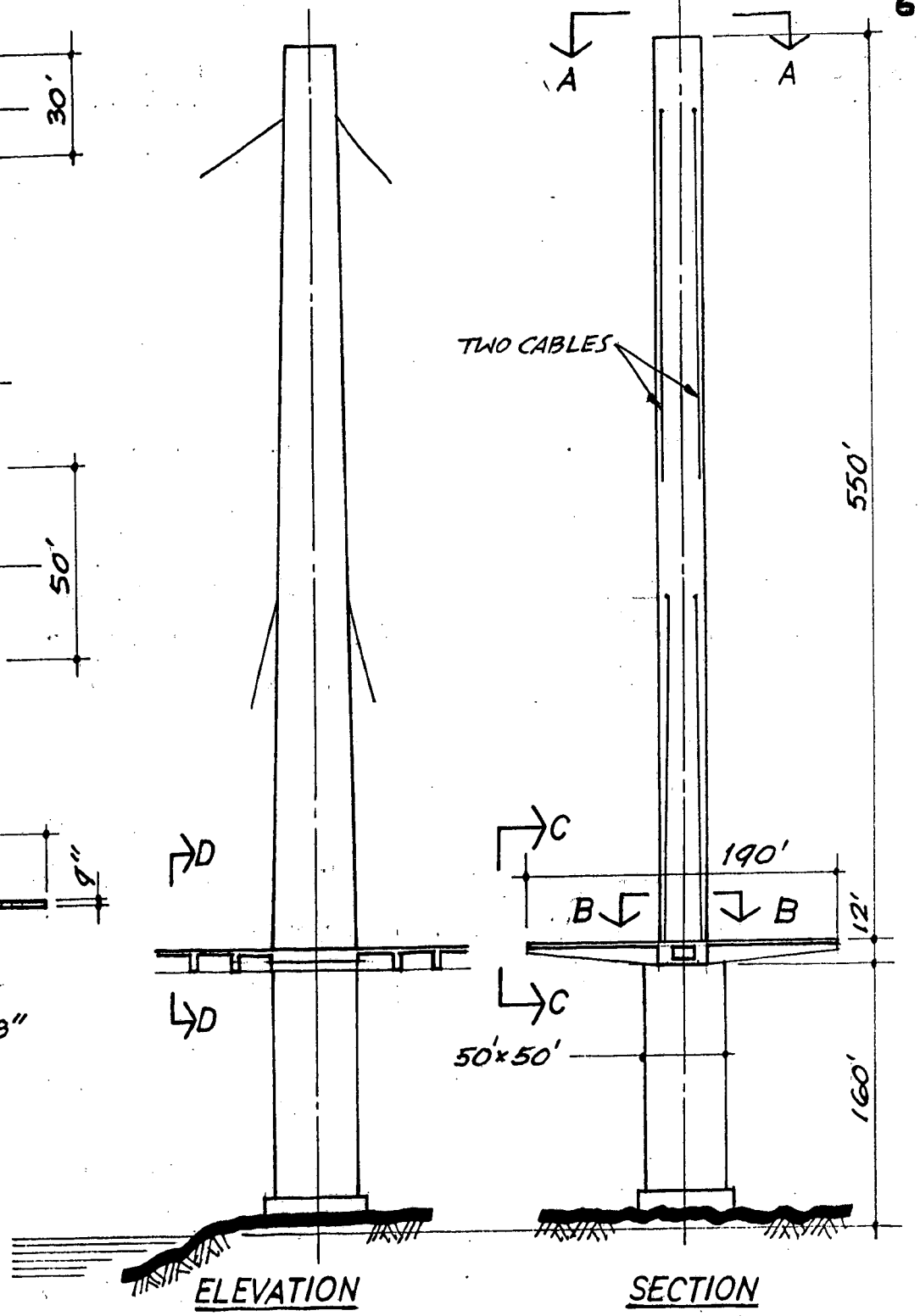

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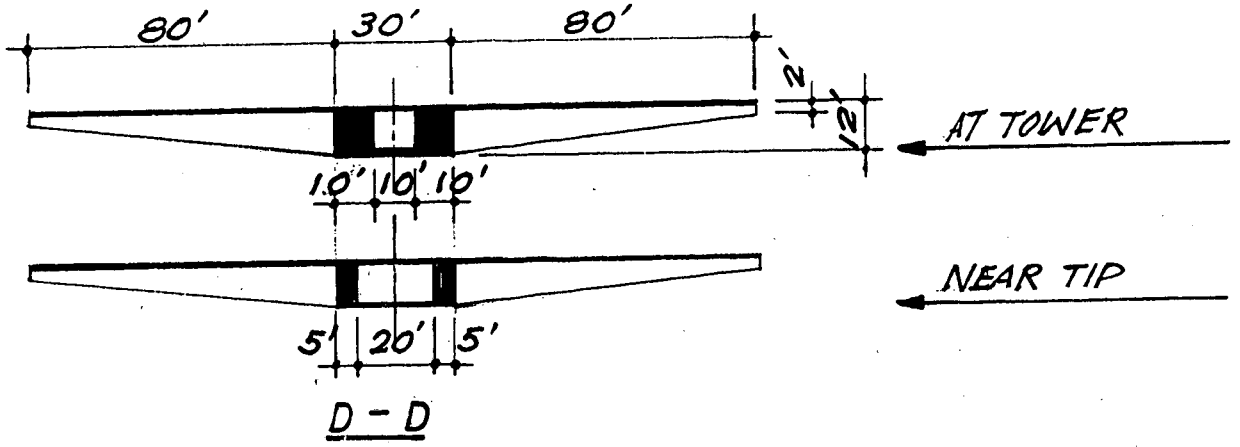
SECTION



D - D

CONCEPTURAL QUANTITY ESTIMATE

Rough quantities of major materials are estimated as follows, using the plan, elevation, and sections shown on previous sheets:

(a) Average thickness of deck concrete including the box spine is about 30-in and the entire deck is prestressed in both directions, requiring only nominal re-bars. Total quantity of post-tensioning tendons, running transversely in the deck, amounts to about 1,000,000-lbs. Concrete $f_c' = 5{,}500\text{-psi} \pm$.

(b) Steel for the stayed-cables totals 5,000,000-lbs, assuming mostly lightweight concrete for the deck.

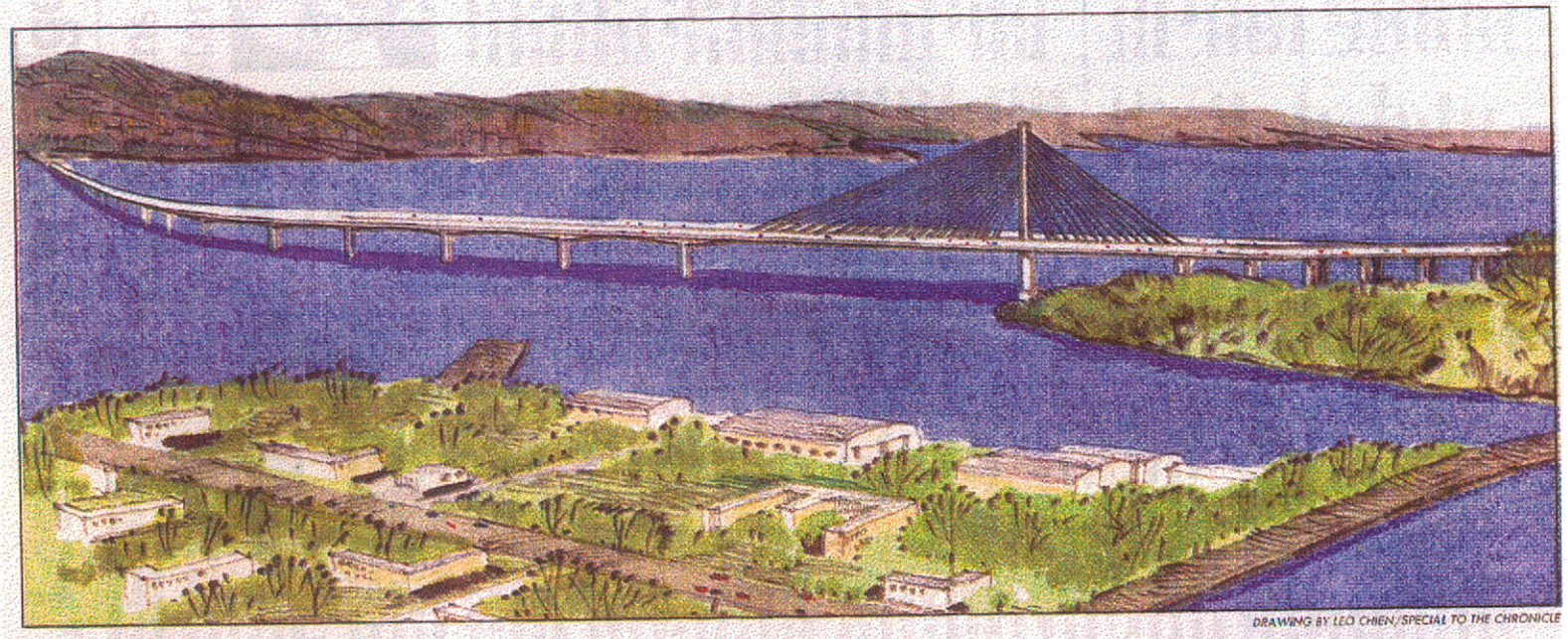
(c) Tower concrete amounts to 16,000-yd^3. It can be easily slip-formed.

(d) 2 sets of horizontal steel slip-forms (area 190 x 25-ft) will be needed, to be designed and built by the contractor.

San Francisco Chronicle
NORTHERN CALIFORNIA'S LARGEST NEWSPAPER
MONDAY, MARCH 10, 1997

COMMUTER CHRONICLES

In Search of a Better Bay Bridge Design



DRAWING BY LEO CHIEN/SPECIAL TO THE CHRONICLE

Renowned engineer T.Y. Lin offers a plan that's nobler and costs $200 million less

Caltrans has given the public an impossible choice between two extremes in rebuilding the eastern span of the Bay Bridge — and neither is nearly good enough for this key setting at the heart of the bay.

ALLAN TEMKO
Environmental Design

One proposal is for a dull, towerless "skyway" that has been likened to an outsized freeway ramp. The other is a madly extravagant "signature bridge," slung from two melodramatic towers, that would be a mockery of the great suspension spans to the west between Yerba Buena Island and San Francisco.

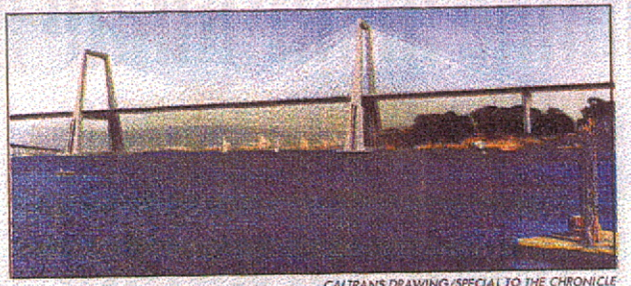
But these schemes are authentic dogs. And there's no reason for us to settle for either of them.

That's why The Chronicle asked the renowned structural designer T.Y. Lin to create a true alternative. And he has responded with a masterpiece that would give the East Bay one of the noblest and most daring cable-stayed bridges in the world.

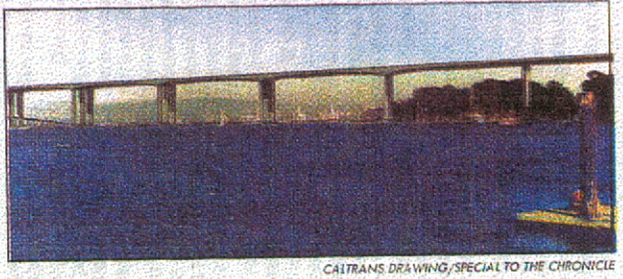
Under Professor Lin's bold concept, a 200-foot-broad concrete deck — gloriously open to the sky — would span the 1,400-foot main channel in a breathtaking display of clarity and confidence. The deck would hang from a single powerful concrete mast 600 feet high, firmly socketed in rock at the edge of the island.

Lin's idea is very preliminary, and it

BAY AREA: *Page A4 Col. 2*



CALTRANS DRAWING/SPECIAL TO THE CHRONICLE



CALTRANS DRAWING/SPECIAL TO THE CHRONICLE

T.Y. Lin envisages a 1,400-foot cable-stayed main span (above), strung from a single mast 600 feet high. The cable-stayed bridge designed by Caltrans would require costly foundations in bay mud hundreds of feet deep and the viaduct alternative is viewed by some to be too bland

Bay Area Deserves Better, Less Expensive Bridge Design

From Page A1

is of course not the only alternative that could be considered, but it opens up a new realm of possibilities.

Under his plan, only two parallel lines of slender cables, set 20 to 30 feet apart, would run down the center of the deck, dividing the westbound from the eastbound lanes.

There would be ample room on either side for a bicycle lane, or a shoulder lane for stalled vehicles, because the exceptional width and weight of the precast concrete roadways — tapering at the sides to give them an aerodynamic form (as they would in the Caltrans schemes) — would help keep the deck from lifting or twisting in earthquakes or heavy winds.

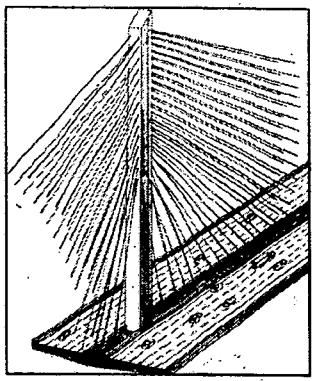
The chief key to the stability of this prodigious deck would be a central structural "spine" — a rectangular concrete tube or "box girder," perhaps 30 feet wide and 15 feet deep, running beneath the roadway the full length of the high cable-stayed spans. The cables themselves, anchored along the spine, would further stiffen the entire system because they would be tightened — "prestressed," in engineering parlance — by the tremendous deck loads.

On the shorter approach spans to the east, such a spine would be unnecessary and there would be a gap between the two roadways.

Engineering logic thus creates an elating liberation of space. The single mast has but a fraction of the mass of Caltrans' huge (but hollow) "portal" towers. The edges of Lin's spans are unobstructed, whereas Caltrans would run cables to either side, possibly creating a dense visual effect, like overlapping mesh screens, when seen at certain angles across water.

Lin's cable-stayed concept, moreover, is asymmetrical. The slender cables, more widely spaced over the main span east of the tower, enhance lightness and grace. Like many cable-stayed bridges around the world, it is perfectly balanced dynamically — a poetic paradox of the engineering.

Of the two rival Caltrans schemes, the spartan skyway has been priced as a $1.1 billion bargain. The cable-stayed, two-tower "signature bridge" — touted by Caltrans' officials as "elegant," although it has a distinct look of student work — supposedly would cost $221 million more.



BY LEO CHIEN/SPECIAL/THE CHRONICLE

Parallel cables are anchored to the spine that divides the span

The cheaper skyway, or viaduct, would be far less disruptive visually — less offensive in every way — than Caltrans' cable-stayed alternative.

Designed (I've been told by reliable sources) by young Caltrans engineers who had no experience with major bridges, it is a classic case of doing things the hard way. The overblown form makes no sense except perhaps as a ploy in Governor Pete Wilson's long-running political sitcom of sticking it to Northern California.

If the decadent Bay Area wants a pretty bridge, Wilson has made clear in his genial Uriah Heep manner, it can damned well pay top dollar for aesthetics.

I have news for him and his bureaucratic minions. The chef-d'oeuvre by Caltrans' in-house Leonardo da Vincis is a couple of hundred million bucks more expensive than necessary, largely because the two-towered scheme sports one tower too many.

In an age of magnificent single-tower cable-stayed bridges, there is no need at all to build the eastern tower, closer to Oakland, which Caltrans would plunk down on one of the squishiest spots of the bay bottom. Supporting piers for this ungainly flat-topped A-frame would have to be driven through hundreds of feet of mud.

A lot of million-dollar bills can be sunk in that maw, particularly because the splayed-out form of the tower — in contrast to a compact central upright — would increase rather than reduce foundation costs.

The eastern tower would not be unbuildable. You can send a rocket to the moon if you wish to spend the money. But it would be a monstrous boondoggle.

As for Lin's design, the price would be right. One of the professor's notable sayings when outlandish sums are quoted is: "Take away a zero."

In spite of Caltrans' scare figure of $220 million extra for a cable-stayed bridge, versus the skyway, he argues that his concept could be brought in for one-tenth that amount — say, only $20 million to $30 million more — and possibly nothing extra at all if Caltrans encounters unexpected difficulties in building the skyway's piers in the mud.

Finally, the technology for cable-stayed bridges of extreme lightness and astonishing length is well established. We are actually living in a golden age of intrepid cable-stayed spans, including sensational new structures in Sweden, France, Britain, the Netherlands, Canada and Saudi Arabia.

Something of that spirit — the spirit shared by Lin and several other outstanding California designers — is needed now for the eastern half of the Bay Bridge. The main reason the skyway viaduct should be discarded is not its blandness but its inability to lift up our hearts and minds.

The old eastern spans of the Bay Bridge, culturally so unfair to Oakland compared to the grandeur of the San Francisco side, are a mishmash of cantilevered, trussed and girder construction; a Depression-era equivalent of the random confusion of the ugly new overpasses that Caltrans has strewn all around the toll plaza approaches, as if a couple of dozen different engineering groups had perpetrated chaos.

That want of vision, that refusal to seek a higher unity, is why we cannot trust Caltrans, aesthetically or otherwise.

The whole idea of the citizenry choosing between two inadequate bridge schemes, as State Senate President Pro Tem Bill Lockyer would like us to do on the Internet, amounts to something close to a hoax.

Caltrans has virtually conceded its ineptitude by offering to consider any suggestions that independent engineers and architects may submit. Professor Lin's concept should be a formidable contender, for it in fact would enhance rather than compete with the suspension bridges on the San Francisco side.

But the public has the right to see other alternatives, and people will not put up with much more dithering by the hapless crew in Sacramento. It's time to end the farce.

Allan Temko won the Pulitzer Prize for Criticism in 1990. He has fought against designs by the state's engineering bureaucracie since his Chronicle articles in the 1960s helped stop freeway construction in San Francisco and led to the redesign of the San Mateo-Hayward Bridge.

Lin's Designs Unify Eastern, Western Views

T.Y. Lin is renowned for functional and beautiful public works

T.Y. Lin is a builder of bridges between peoples and places. Not only has he conceived visionary (but technically feasible) structures, but he has also sought to incorporate them with both Eastern and Western philosophies.

When he was honored as the University of California's Alumnus of the Year in 1995, his acceptance speech characteristically was a tribute to both Confucius and Isaac Newton, whose principles coexist in his unified world view.

Born in old Foochow, China, in 1911, Tung-Yen Lin — always called "T.Y." by family and friends — came to UC Berkeley as an engineering graduate student in the 1930s and quickly distinguished himself as a structural theorist with a bent for practical building.

He returned to China in the 1930s as a railroad engineer, then was invited back to Berkeley after World War II. He soon became a mainstay of one of the most brilliant engineering faculties in the world, where for the past two decades he has been professor emeritus.

He became internationally famous in the 1950s as the foremost U.S. developer of prestressed concrete. Taking advantage of this revolutionary material, he pushed building technology beyond existing limits in bridges, arenas, convention facilities and other long-span structures of surpassing lightness and grace in Asia and Latin America as well as the United States.

In San Francisco, the 300-foot arches of Moscone Center are his most spectacular achievement. But his single most poetic design, still unbuilt, is for the Ruck-a-Chucky Bridge in the Sierra foothills above Auburn, whose slender 1,300-foot deck — hung from cables anchored in the surrounding mountainsides — would curve freely above a gorge of the American River.

In some ways, it was a forerunner of the daring cable-stayed concept he now proposes for the eastern spans of the Bay Bridge.

— Allan Temko

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Box 7, Folder 8

Item 2

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